CHAPTER D.8
BEST MANAGEMENT PRACTICES FOR COSTAL RESTORATION IN LOUISIANA

Thomas Campbell[1]
Lindino Benedet[2]

[1,2]*Coastal Planning and Engineering Inc.*
2481 NW Boca Raton Blvd., Boca Raton, FL 33431

8.1 ADAPTIVE MANAGEMENT

8.1.1 Summary

This chapter discusses the importance of insuring that lessons learned are incorporated into the restoration program for Louisiana's barrier shoreline. These course corrections can best be implemented through the use of sound models, designs, and monitoring systems.

As suggested in the LCA Science Workshop (2003), adaptive management is a systematic process in which learning from the outcomes of operational programs allows for continual improvement of management policies and practices. Adaptive management plays a key role in policy planning for major restoration programs (e.g. the Everglades Restoration Program, the Chesapeake Bay Program, and the CALFED Bay-Delta Program). Three main components are shared by adaptive management programs (Thom 2000):

- a clear goal statement
- a conceptual model
- a decision framework

There are significant uncertainties regarding the physical processes that control retreat of barrier islands in Louisiana. For this reason, it is important to develop an effective adaptive management program and define an initial conceptual model that will be fed by monitoring data. The program should consist of the components described below.

8.1.2 Preliminary Conceptual Model

A preliminary conceptual model as hypothesized in Chapter 6 should be developed. The model would quantify the movements of sand and finer sediment (silts, clays) in response to sea level rise, storm impacts, and longshore losses to inlets. The model would thus explain the observed retreat and acreage loss of Louisiana barrier islands and adjacent wetland habitats. The forcing functions that require quantification include profile response to relative sea-level rise (including land subsidence and eustatic sea-level rise), gradients in longshore transport and sediment losses to ebb-tidal deltas (e.g. Fitzgerald et al. 2003), storm-induced breaching, and overwash. Further model development will include calibration to reproduce measured changes in the barrier islands and relate those changes to estimates of sand and mud movements within the system.

8.1.3 Design and Construction

Design templates for barrier island restoration should use sands and marsh sediments in a configuration that mimics natural profiles. The constructed profile should contain sufficient sediment to perform the design function and allow for long-term erosion.

The design approach should be refined based on experience gained through monitoring, as well as on the conceptual model that explains measured retreat rates and acreage changes. Managers, engineers, and coastal scientists must learn from the track records of prior projects and revise management and policy to improve the success rate of future efforts. Design and construction of fill placements on barrier islands must be followed by monitoring for shoreline and volume change and for further development of cause-effect relationships. This information will help refine the preliminary conceptual model. Whenever possible, monitoring results should be used in lieu of numerical model predictions.

8.1.4 Monitoring and Evaluation

There has not been sufficient monitoring of constructed islands to date. Constructed islands should therefore be monitored for shoreline and volumetric losses above and below the water surface. Surface samples should be taken from the entire active beach profile to define the limits of sand and mud systems. Theories of island movement as proposed or estimated in the preliminary conceptual model should be refined, based on model assumptions and feedback from monitoring data.

8.1.5 Feedbacks Between Monitoring and Design

In order to be to be consistent with monitoring results, the conceptual model should be modified as new information becomes available. Island designs should be modified by incorporating mechanisms described and quantified in the upgraded conceptual model. Hot spot erosion areas should be beefed up with greater fill densities. Structural enhancements should be considered for the highest erosion areas if fill solutions are not feasible.

8.2 BARRIER ISLANDS

8.2.1 Summary

This section outlines specific guidance for restoring Louisiana's barrier islands. Design and construction parameters are presented, as is a discussion of the use of channel maintenance sediments for restoration projects.

The design of barrier island restoration projects in Louisiana will differ from most coastal restoration projects in four ways:

1. Louisiana barrier islands exhibit high retreat rates that are an order of magnitude greater than other areas where beach nourishment is being practiced.
2. The primary purpose of nourishment in Louisiana is protecting marsh and habitat, not the more common priority of protecting recreation and infrastructure (e.g. Miami Beach).
3. Efficiently managing the unique sediment resources along Louisiana's shoreline, including the interaction of mud (mixed fines and organic matter) and sand systems, will require further conceptual and quantitative research.
4. The high rate of relative sea-level rise combined with tidal influence from adjacent basins (bays) create unique design challenges.

Coastal design approaches for Louisiana should be customized, and monitoring of constructed projects must be a priority. Analysis of the predominant processes in different scales (e.g. single barrier island, sections of the coast, hydrological basins, and entire Louisiana coast) and regional sediment budgets can provide powerful tools to support design strategies for individual projects. These analyses can also help develop efficient regional sediment management procedures that will sustain the coast over the long-term.

The following items describe best management practices and discuss options that will optimize restoration of Louisiana's barrier islands. The design features are a result of the LCA team effort (e.g. the LCA Science Workshop held in 2003 and numerous meetings between the LCA science team, LDNR, and the USACE-New Orleans District).

8.2.2 Design and Construction Considerations for Gulf Shoreline Restoration

8.2.2.1 Development of a conceptual model and regional sediment budget

Designs should be based on a conceptual model of physical processes in each project area. The model should describe and quantify the sediment transport components viz. longshore and cross-shore (beach-offshore and across the island) that are responsible for changes measured in the barrier island systems.

8.2.2.2 Sand depth of closure

We recommend the use of a shallower sand depth of closure (Doc-s) located at the depth where the sand profile (steeper) intersects the mud profile (flatter). This will facilitate development of a sand littoral budget and identify the design sand needs of the beach-dune component for barrier island restoration projects. A comprehensive surface sediment mapping to identify the sand/mud interface in different sections of the coast is also suggested. Surveys of submerged beach profiles may be used to identify the sand/mud interface (i.e. the location of an abrupt slope change from a steep, sand-dominated profile to a flat mud-dominated profile).

8.2.2.3 Template

The most important aspects of design and construction templates are as follows:

a. Projects should clearly differentiate between the design and construction templates.

b. The appropriate template for each coastal segment will depend on the primary purpose of the project (see Chapter 9 for details).

c. The design focus should be on volumetric requirements of sands and mixed backbarrier sediments (sand, silt, clay), rather than on design templates. See Chapter 10 for details regarding templates.

d. The island's natural slopes should form the basis of the design profile unless higher templates are built.

e. Consideration should be given to the construction of storm protection beach berms on the Gulf shoreline. A berm will serve as a buffer and allow for beach-bar interaction (e.g. Komar 1997) during storms. In this way, the berm will serve as a sand reservoir for bar formation during wave attack. This, in turn, will diminish the frequency of overwash and favor the establishment of dune and marsh vegetation.

8.2.2.4 Advanced fill

The amount of sediment expected to erode before the next renourishment should be added to the design quantities. As a result of adding this extra sediment (advanced fill), construction profiles will be wider and higher than the design profile.

8.2.2.5 Monitoring and maintenance

Because beach nourishment is an ongoing process, the Louisiana coastal protection program should be envisioned as a series of construction/nourishment cycles (e.g. 10 years). Such cycles should be built into the overall restoration program in order to maintain the coast for the long-term. Each project budget should include funds for monitoring to allow the performance assessments that are necessary parts of the adaptive management process. On the renourishment journey, monitoring provides a course correcting mechanism that helps the program realize its goals and objectives.

8.2.2.6 Two side nourishment of barrier islands

Historical data for shoreline change in Louisiana's barrier islands (e.g. Williams et al. 1992) have demonstrated that while beaches and dunes roll over and migrate landward, marshes do not generally prograde landward at the same rate. Recent surveys of Louisiana's barrier islands confirm historical data and show that as the beaches/dunes move north, the bayside shoreline usually remains stable or moves in the opposite direction (e.g. south). The result is loss of marsh area as the beaches/dunes roll over on top of the marsh. The most appropriate design approach in this case is to restore gulf shoreline (beach/dune) and bay shoreline (marsh) simultaneously. This two-side nourishment will enhance the existing island template (Figure D.8-1).

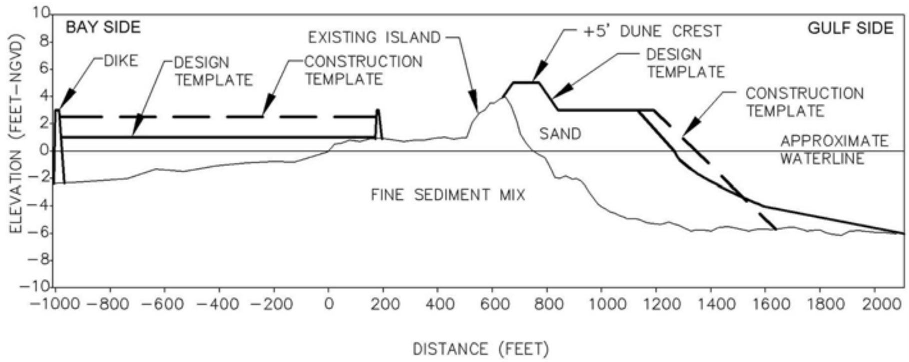


Figure D.8-1. Proposed two-side nourishment template for the restoration of the eastern flank of Grand Terre Islands, Louisiana Plaquemines shoreline.

Current trends suggest that long-term maintenance needs may be greater for bayside nourishment (e.g. marsh) than for gulfside nourishment (e.g. beaches and dune). Design approaches should take this information into consideration.

Barrier island retreat and volumetric loss. Several previous design analyses (e.g. Van Beek and Meyer Arendt 1982; T. Baker and Smith 1997) estimated sand loss rates based on historical retreat rates. These analyses applied a rule of thumb developed by the U.S. Army Corps of Engineers (USACE) to estimate beach erosion from historic maps and aerial photographs (USACE 1973). Walton and Dean (1976) refined the USACE rule of thumb, calibrating the constant "K" to local conditions ("K" given by Equation 1). The constant "K" then relates the amount of retreat in order to obtain cubic yards (volume) lost per each linear foot of retreat.

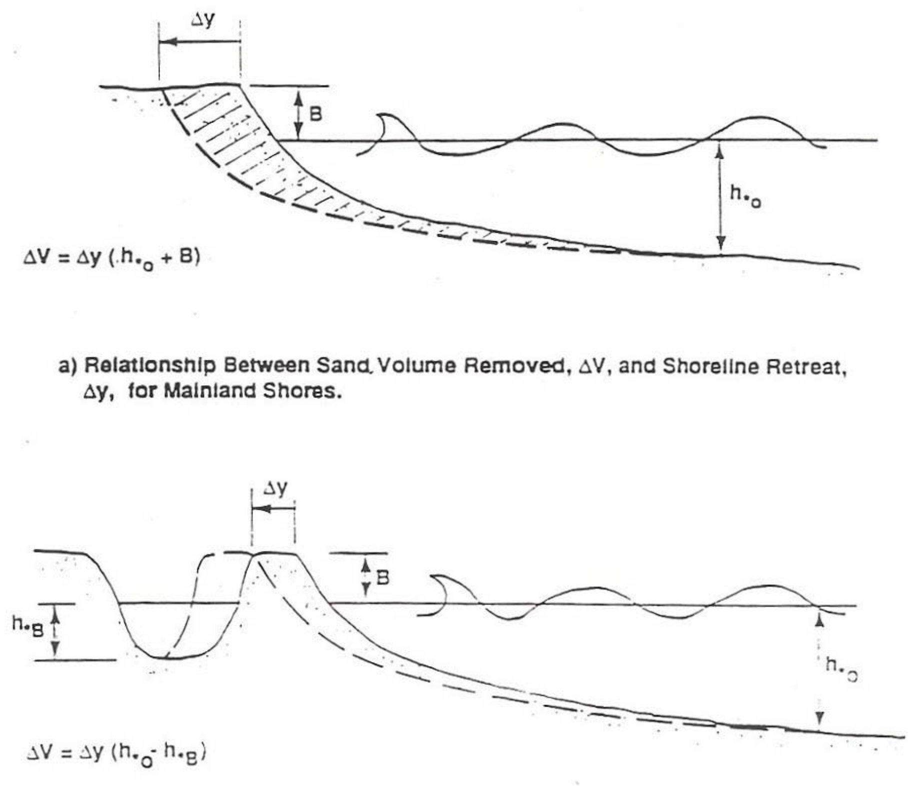
$$K= (Bh + D_{oc})/27 \text{ ft3/cy3} \qquad \text{Eq. 1)}$$

Walton and Dean (1976), for example, estimated a K=0.89 for Captiva Island (Gulf Coast of Florida), meaning that for each foot of retreat, 0.89 cy of sand from the face of the island is lost (and vice versa).

For Louisiana, K values will range from 0.35 to 0.7 depending on Doc and berm/dune height values. However, this method assumes that retreat is caused by longshore losses and can be directly related to volumetric loss of sand. As a consequence, this method is not valid for the Louisiana coast. In Louisiana, the mud/sand system is retreating (rolling over) due to cross-shore processes (e.g. overwash and profile response to relative sea-level rise) and is not directly related to volumetric loss.

The following explanation will help explain this concept. Subearial barrier island sand density is generally on the order of 70-100 cy (54-77 m3) of sand per running foot of island frontage. If there was a direct correlation between retreat rates and sand loss, then an island with an elevation of 5 feet (1.5 m) and a depth of closure of 7 feet (2.1m) would lose half of a cubic yard (0.4 m3) for each foot (0.3 m) of retreat. According to this rationale, an island with a retreat rate of 30 feet per year (9.1 m/yr) would lose 15 cy (11.5 m) of sand per running foot (0.3 m) per year, and the island would completely erode in five to seven years. Fortunately this scenario is not observed in the field, and most barrier islands still exist today.

Dean (1991) proposed a method for calculation of volumetric loss as a function of retreat on barrier islands that are constantly overwashed. His approach is illustrated at Figure D.8-2.



a) Relationship Between Sand Volume Removed, ΔV, and Shoreline Retreat, Δy, for Mainland Shores.

b) Relationship Between Sand Volume Removed, ΔV, and Shoreline Retreat, Δy, for Barrier Island Beaches.

Figure D.8-2. Relationships between volumetric loss and shoreline retreat for mainland beaches and barrier shorelines (after Dean 1991).

Our approach adapted the methodology of Dean (1991) to calculate volumetric loss based on retreat rates of barrier islands that are frequently overwashed and have a marsh and backbarrier bay. The method developed in this work is based on depth of intersection between sandy and mud profiles (sand depth of closure), marsh platform height, and differentiation between cross-shore and longshore components that cause measured barrier island retreats. Measured retreat rates of each barrier island are caused primarily by cross-shore processes (e.g. submergence, overwash, marsh compaction, profile response to relative sea level rise) and secondarily by loss of sediment alongshore (longshore processes) to tidal inlets or adjacent islands. The total retreat rate, therefore, is represented by a sum of the cross-shore and the longshore components (Eq. 2).

$$\Delta x_{Total} = \Delta x_{CS}(\text{cross-shore}) + \Delta x_{LS}(\text{longshore}) \qquad \text{(Eq. 2)}$$

and

$$V_{Total} = V_{Cross\text{-}shore} + V_{Longshore} \qquad \text{(Eq. 3)}$$

Where Δx_{Total} is the measured retreat (as measured from aerial photographs, historical nautical charts, and maps); Δx_{CS}(cross-shore) is the cross-shore component of the retreat; Δx_{LS}(longshore) is the longshore component of the retreat; V_{Total} is the total volumetric loss; $V_{Cross\text{-}shore}$ is the volumetric loss due to cross-shore processes; and $V_{Longshore}$ is the volumetric loss due to longshore processes.

The longshore component ($V_{Longshore}$) can be estimated by:

- buildup on ebb and flood shoals;
- measuring area of bays, increasing tidal prism, and comparing potential and current size of ebb-tidal shoals; (Note: there should be a lag between potential and actual sizes of ebb-shoals.)
- rate of sand spit development in the end of the system or adjacent to the island;
- regional sediment budget that considers the above;
- approximation based on longshore transport equations. Remember that rates of longshore loss from other Gulf of Mexico barrier islands are typically between 30,000 to 100,000 cy/yr.

When none of this data is available, one can initially assume that 20% of barrier island losses are due to longshore processes [empirical factor based on previous detailed project designs and weighting relative importance of a relative sea level rise of 1 cm/yr (Penland and Ramsey 1990)] and the very mild wave climate.

The cross-shore component considers that the front of the island (beach and dune) is migrating landward and covering backbarrier marshes on sand rich islands during minor storms. On sand deprived islands and/or during major storms, the marsh sediment would be directly eroded by wave action due to exposure on the Gulf side (e.g. Figure D.8-3). As a result of either one of the above processes, the marsh sediment is lost by either compression (sand rich islands) or wave erosion (sand deprived islands, major storms) (Figure D.8-4).

Marsh at Gulf Shoreline

East Grand Terre
July 8, 2003

Figure D.8-3. Pictures depicting the exposure of fine sediments and marsh vegetation on the Gulf side of the Central Segment of East Grand Terre Island.

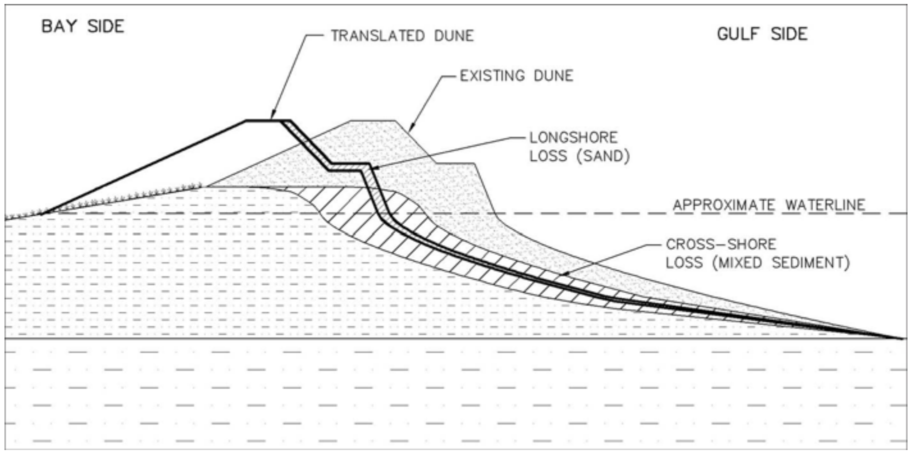


Figure D.8-4. Schematic diagram illustrating barrier island volumetric losses (only applicable for barrier islands where minimum beach and dune cross-sections exist).

The cross-shore volumetric loss is equal to the cross-shore retreat (total retreat - longshore component) converted into volume by a direct relationship between marsh height and closure depth.

$$\text{Vtotal} = \Delta\text{xCS(cross-shore)}*(\text{Doc}+\text{Mh (marsh height)}) + \Delta\text{xLS (longshore)}*(\text{Doc} + \text{Bh(berm height)}) \quad \text{(Eq. 4)}$$

Where ΔxCS is the cross-shore component of the retreat, D_{oc} is closure depth, Mh is marsh height and Bh is berm height.

Using American units (1 cy = 27 ft2) and average dimensions of Louisiana barrier islands (Mh = 2 ft, Bh = Dune height = 5 ft, D_{oc} = 7 ft) we have:

$$\text{Vtotal} = (\Delta\text{xCS(cross-shore)})/4 + (\Delta\text{xLS(longshore)})/2.2 \quad \text{(Eq. 5)}$$

If the longshore loss rate is not available, it may be useful to assume initially that the longshore component is 20% (1/5) of the cross-shore component. The volume loss can then be approximated by:

$$\text{Vtotal} = (\Delta\text{xtotal})/3 \quad \text{(Eq. 6)}$$

For a given barrier island and lifetime (T), the total volumetric loss as a function of retreat is:

$$\text{Vtotal} = (\Delta\text{xCS(cross-shore)})/4* \; T* \; \text{BILenght} + (\Delta\text{xLS(longshore)})/2.2)* \; T*\text{BILength} \quad \text{(Eq. 7)}$$

The method can be calibrated to local conditions (according to berm height, marsh height, depth of closure, and retreat rate) and applied to develop initial volumetric loss requirements for barrier island restoration projects.

To facilitate understanding of this rule of thumb, a practical example is given below. If an hypothetical project is 5 miles (26,400 ft) long, the design lifetime (T) is 10 years, and the average measured retreat rate (ft/yr) on the Gulf side of the island is 30 ft/yr then:

V_{Total} = ((Δx_{Total} * T* BILength)/3

V_{Total} = (30*10*26400)/3

V_{Total} = 2,640,000; this value is equivalent to a density of 108 cy/ft or 10.8 cy/ft/yr

Suppose that a sediment budget was developed, and the known rate of longshore loss is 36,000 cy/yr then, T remains 10 years and BILength remains 26400, then:

V_{LS} = 36,000/26400 = 1.33 cy/ft/yr

For Δx components:

If (V_{LS}) = Δx_{LS}/2.2 then:

Δx_{LS} = V_{LS}*2.2 = 1.33*2.2 = 3 ft/yr is the retreat due to the longshore component.

Δx_{CS}(cross-shore)= ΔxTotal - Δx_{LS}(longshore) = 30 - 3 = 27 ft/yr is the retreat due to the cross-shore component.

V_{Total}= (Δx_{CS})/4* T* BILength + (Δx_{LS})/2.2)* T*BILength

V_{Total} = ((27/4)*10*26400) + (3/2.2*10*26,400)

V_{Total} = 2,133, 000; this value is equivalent to a density of 81 cy/ft or 8.1 cy/ft/yr

V_{LS} = 351,115 cy; this value is equivalent to a density of 13.3 cy/ft or 1.3 cy/ft/yr and is predominantly a loss of sand.

V_{CR} = 1,782,000 cy; this value is equivalent to a density of 67 cy/ft or 6.7 cy/ft/yr and is predominantly a loss of mixed sediments.

The volumetric estimates obtained by the method described herein represent an estimate of the advanced fill or maintenance volumes necessary for the design of barrier island restoration projects.

8.2.2.7 Breach and inlet closures

It may be desirable to close certain passes to recreate the historical barrier island configuration, provide wave protection, and avoid salinity increases in bay marshes and other estuarine environments. A reduced number of passes may also reduce longshore losses of sediment to ebb-tidal shoal systems. However, the decision to close passes should be based on a cost benefit analysis and a scientific examination of the relationship between the cross-section area of existing passes and tidal prism.

Transgressive barrier islands of abandoned delta lobes are frequently overwashed and become narrower naturally. This narrowing occurs by longshore and cross-shore readjustments as well as by losses of sediment, which ultimately leads to island breaching. Breaches can, in turn, become major passes if the hydraulic efficiency of the tidal flow through the new breach exceeds that of alternate paths for the the back bay tidal current.

The volume of tidal exchange, or tidal prism, is dependent on the bay area and tidal amplitude. As bay area increases due to marsh retreat and submergence, the tidal prism increases. The amount of sand stored in ebb shoals of equilibrated inlets is proportional to the tidal prism. Bay area increases, therefore, increase losses from the barrier islands to the inlets as the ebb shoals evolve to their equilibrium size. The rate of ebb shoal growth (and sediment loss from the beach) depends on:

- the level of disequilibrium of the ebb shoal
- the number of inlets and nature of the openings (man-induced or natural)
- the rate of longshore transport.

Consequently, islands with multiple inlets (e.g. Isles Dernieres) have ebb shoals that are closer to equilibrium, with significant sand quantities trapped in the ebb shoal system. Closing of breaches could significantly decrease island longshore losses by reducing the number of sediment sinks. However, because tidal prism has significantly increased in backbay areas (Lake Pelto, Timbalier Basin, and Barataria Bay; Fitzgerald et al. 2003), inlet closing should be done in conjunction with:

- building the island high and wide enough to prevent breaching after closures are constructed; and/or
- developing strategies to manage tidal prism/ flow.

Tidal prism/ flow can be managed either by reducing the size of the bays (e.g. building marsh or ponds) or by redirecting tidal flows to deeper major inlets. The latter can be accomplished by dredging canals in the backbay that connect to major outlets. In Florida’s west coast, for example, a number of smaller tidal inlets started to shoal naturally after the West Coast Intracoastal Waterway (ICWW) was dredged in 1965. This occurred because the ICWW redirected tidal prim/flow from the smaller inlets to single, deeper, and larger inlets. As a consequence, a number of small inlets closed naturally over a period of 10 to 30 years.

Closing an inlet can often be difficult and usually requires a combination of structures and fill. The fill density needed to nourish a breached section may be up to three times higher than that of adjacent beach areas. Even though difficult and possibly expensive, closure of specific inlets/passes may be justified by the economical and ecological benefits.

Candidates for closure include:

- recent breaches on all islands, where volumetric requirements are still low
- areas where tidal flow can be re-directed to reduce future breaching possibilities
- areas where extensive marsh systems are close to island ends or passes, and can be protected by the inlet closure
- areas where there is more inlet cross-sectional area than that what is required to efficiently drain the tidal flow
- areas where the breach/pass is threatening existing infrastructure on the islands or landward; or threatening the sustainability of adjacent environments.

8.2.2.8 Restoration priority

Priority should be given to maintaining coastal features that protect large marsh areas and restoring weak low spots on endangered islands.

8.2.2.9 Mainland and bay shorelines

Along with barrier island restoration, mainland bay shorelines must also be protected in order to reduce bay area increase and tidal prism growth (Winer 2003; personal communication).

8.2.3 Design, Construction, and Consolidation Considerations for Marsh Restoration

Constructed marshes will be subject to three modes of vertical adjustment:

1. initial consolidation, as the hydraulic fill placed in the marsh dewaters and consolidates (one to 12 months);
2. subgrade compression and settlement under the overburden of placed material (estimated at 10 to 20% of consolidated overburden thickness; one to five years); and
3. relative sea level rise, which consists of eustatic sea level rise and the pre-construction land subsidence rates of the region (design lifetime to longer-term).

When low elevation islands are constructed, the vertical displacement due to the third process can generally be compensated for by the marsh's ability to build up by overwash processes and natural marsh dynamics (e.g. organic matter production and accumulation). On higher restored templates (e.g. 12 ft) where overwash is restricted, relative sea-level rise design will have a greater impact on marsh loss and will result in larger volumetric requirements.

For design and construction purposes, the concepts of design-grade and construction-grade are introduced. The design-grade addresses long-term processes (e.g. Processes 2 and 3 above), while the construction grade adds volume in the short-term to account for Process 1. Considerations for design of these components are as follows:

- The marsh elevation (design grade) should be intertidal at the mid-point of its design life.
- Sediment used to construct the marsh may contain a mix of sand, silt, and clay. Some cohesive sediment can improve the survivability of the planted vegetation, while sandy sediments will contribute to fill stabilization.
- The bayside of barrier island marsh could be stabilized with rocks or sand filled tubes to reduce wave erosion. This can be applied where historic records or monitoring show significant long-term erosion of the bayside marsh, and where Gulf shoreline migration is prohibited by the construction of higher island templates.

8.2.4 Construction/Plans and Specs.

- Typically, the marsh is constructed within a contained dike system. The bayside containment may include stabilizing structures as discussed above.

- Ideally, the marsh is initially constructed at the construction grade. This is higher than the design grade to allow for initial consolidation and dewatering of the hydraulic fill, which will reduce the dredged material's height by about half. It is possible to improve this estimate by geotechnical analysis of the fill material and/or inspection and monitoring of similar projects. Geotechnical analysis to account for expected long-term (e.g. one to five years) consolidation of the subgrade materials under the new overburden may also help determine the appropriate elevation of the construction grade. Whether the geotechnical analyses are used for predicting short or long-term consolidation, the analyses will be based on soil borings and will often include: (1.) laboratory testing of soil parameters such as Attemberg limits, particle size distribution, hydrometer, and organic content to classify the material; and (2.) unit weight, moisture content, unconfined compression, and single unconsolidated-undrained triaxial compression tests to determine shear strength characteristics of the material. Consolidation tests may also help to determine soil compressibility and stress history.
- Grade stakes should be placed on a grid (e.g. 200 X 200 ft) within the marsh area. The stakes clearly mark the construction grade so that it is visible from the dune. This will allow visual confirmation of construction elevations without the need for a conventional topographic survey of the unstable mud surface.
- When cohesive material percentages exceed 20%, placement of sediment in layers or lifts may facilitate dewatering and consolidation (LDNR 2003).
- Sand placed as an underlayer to muds may reduce construction problems (Lee and Thibodeaux 2003, personal communication).
- Ideally, marsh vegetation is planted after design elevations are achieved through settlement and consolidation. The placed sediment is allowed to settle for a significant time (e.g. six months to one year) before vegetation is introduced. Grand Terre Island adopted this strategy and was the most successful marsh restoration and vegetative planting project to date in Louisiana's barrier coast (Grandy et al. 2003, personal communication; see Figure D.8-5).

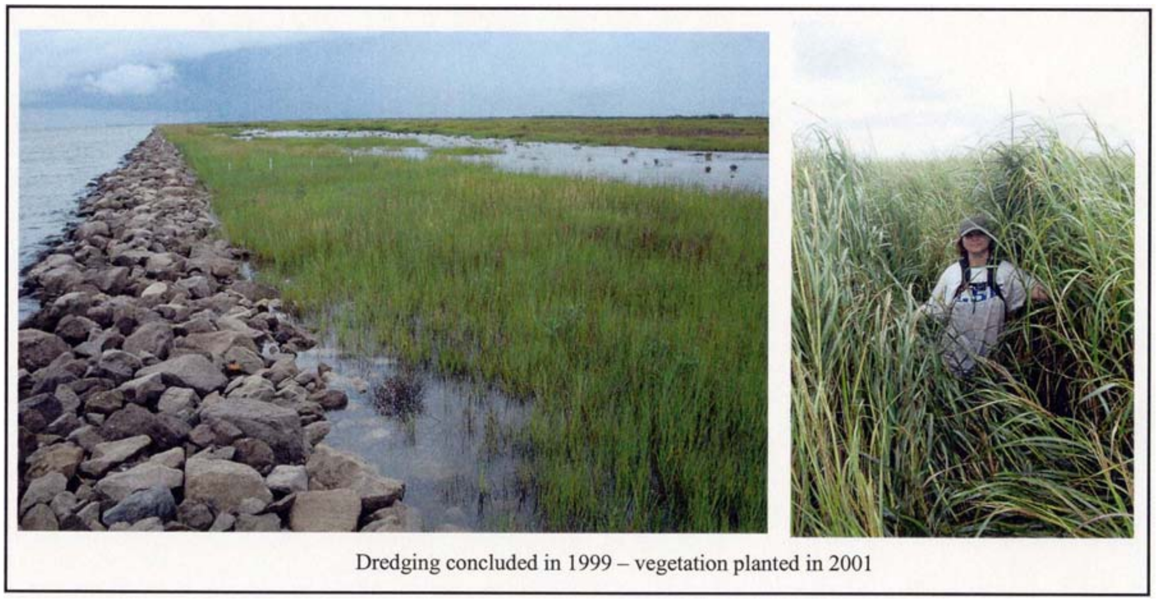


Figure D.8-5. Illustration of vegetation planted on Grand Terre Island. Photographs taken in August 2001, courtesy of Darin Lee, Louisiana Department of Natural Resources.

8.2.5 Review of the Barrier Island Feasibility Study Restoration Strategies

The Barrier Island Feasibility Study (T. Baker & Smith, 1997) developed a comprehensive plan for barrier island restoration in Louisiana. However, the long-term volumetric estimates of the study may be significantly greater than what is actually needed.

In the Barrier Island Feasibility Study, two main factors may have contributed to the higher estimates: (1.) closure depths deeper than sand closure depths (Doc-s) were used, and (2.) the sediment compatibility parameters used (e.g. overfill factors) tended to overestimate volume.

A new detailed coastal analysis with site-specific conceptual models and applications of practices described in this document, together with a regional sediment budget and sediment management strategies could result in significantly smaller volumetric requirements.

8.2.6 Use of Channel Maintenance Sediments for Barrier Island Restoration

Sediments from dredged navigation channels could be used to help restore Louisiana's eroding barrier islands. For example, the USACE analyzed sediments from a disposal site at Cat Island Pass and described the dredged material as 70% sand, 5% shell, and 25% silt. Coastal Environments (1982) using results from the USACE (1975) suggested that dredge spoils could be used for beach nourishment, dune construction, and back barrier fill. Jones/LDNR (1985) described successful examples of a restoration project on East Timbalier Island (constructed in 1983) that was built with fine grained dredge spoil from Cat Island Pass. On the Louisiana coast, several channels are regularly maintained, and beneficial material is used for coastal restoration in many of them. In the Chenier Plain, USACE channel maintenance programs include Calcasieu Pass, Mermentau River, and Freshwater Bayou. Beneficial material from the Houma Navigation Channel can be used mainly for marsh restoration of Trinity and East Islands (e.g. Jones 1983).

Port Fourchon (Belle Pass) maintenance material can be used for the restoration of the downdrift shore [(portion of the Caminada Moreau Headland west of Belle Pass, (e.g. CWPPRA project TE23)]. Material from the Barataria waterways can be used for marsh restoration of the adjacent East and West Grand Terre islands (e.g. CWPPRA project BA 28). Material from the Empire Waterway, Tiger Pass, and Southwest Pass can be used for marsh restoration of the southeastern section of the Plaquemines shoreline, and material from Pass a Loutre, Main Pass, and MRGO channel maintenance can be used to create habitat on (spoil islands) and promote restoration of the south Chandeleur Islands (Figure D.8-6).

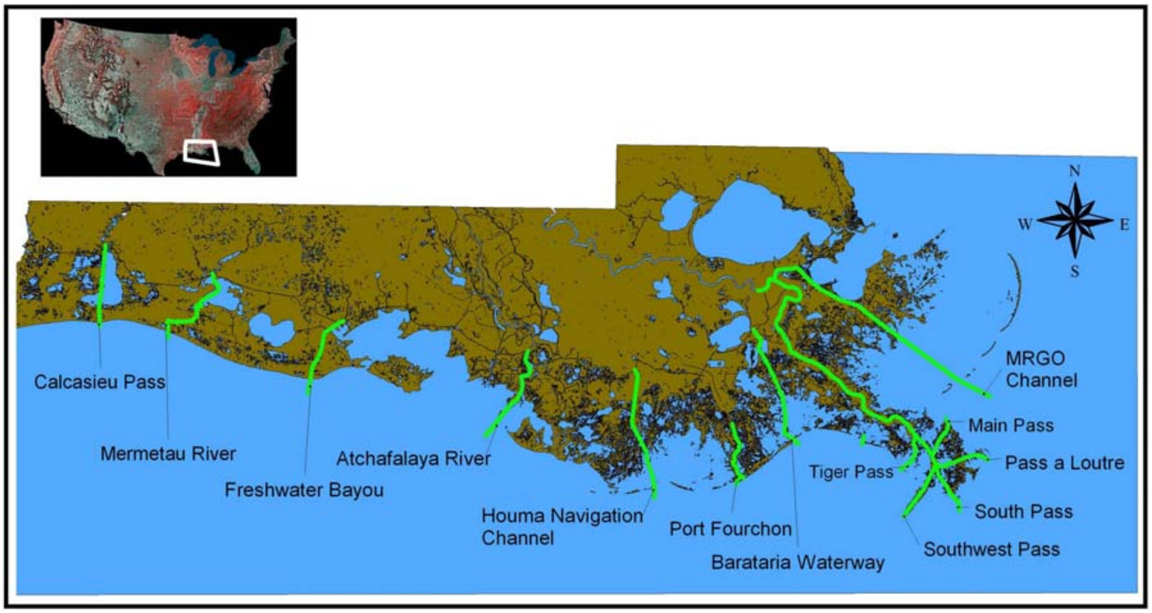


Figure D.8-6. Location of major Gulf outlets (navigation channels) regularly maintained by the U.S. Army Corps of Engineers, New Orleans district. Beneficial material from these channels is recommended for restoration of back barrier slopes and marshes and creation of new marsh habitats ("spoil islands").August 2001, courtesy of Darin Lee, Louisiana Department of Natural Resources.

8.3 BEST MANAGEMENT PRACTICES FOR COASTAL STRUCTURES

This section provides guidance for using coastal structures in conjunction with beach nourishment programs. This section also describes how to minimize the downdrift erosion caused by structures. For specific discussions regarding the use of structures on the Louisiana coast, see Chapter 6, "Restoration Tools."

The use of structures may, in some cases, improve the performance of beach nourishment projects (USACE 2002; Silvester and Hsu 1997; NRC 1995). Examples of beach nourishment projects operating in conjunction with structures are shown in Figure D.8-7.

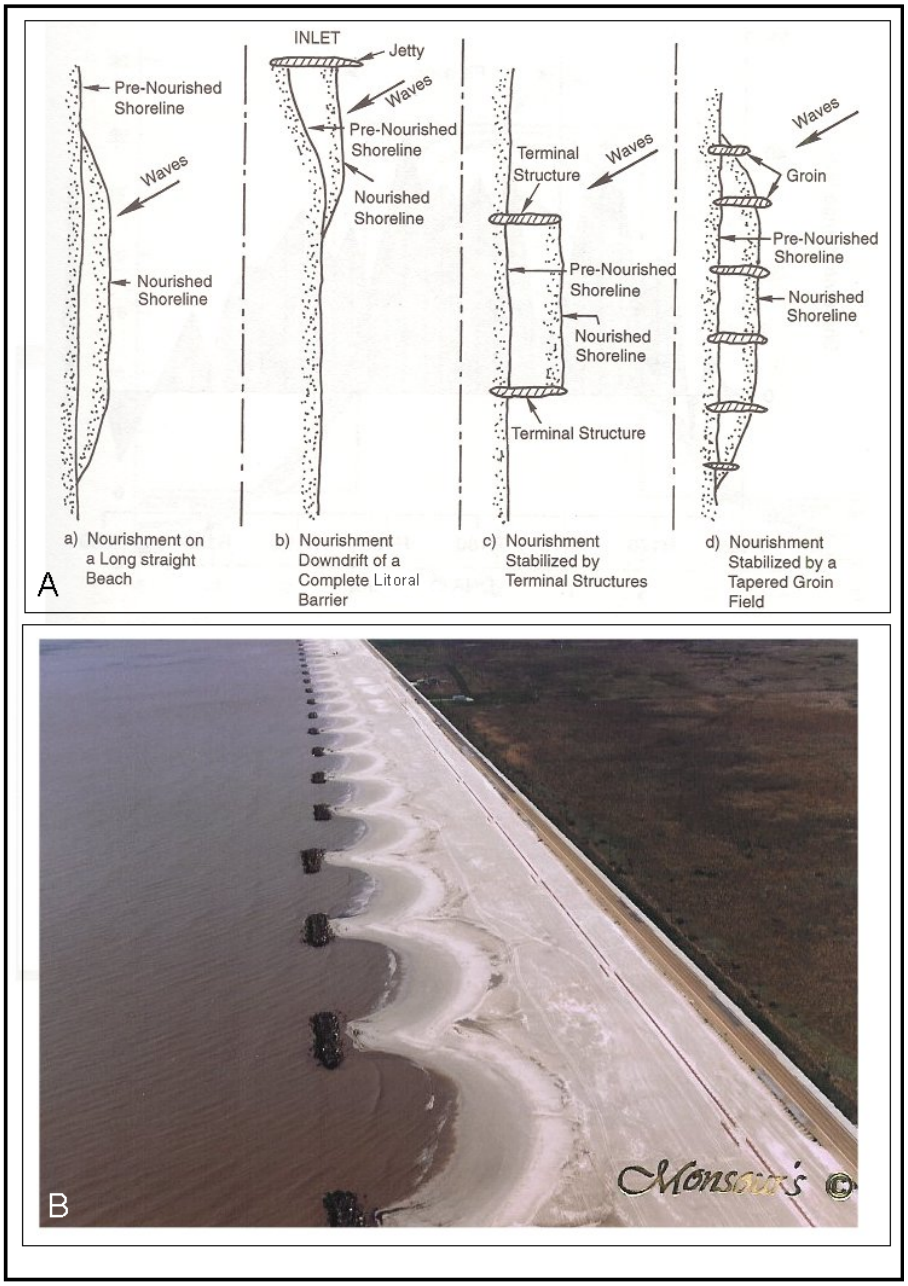


Figure D.8-7. Beach fill placed in conjunction with stabilizing structures on an open coast, or coasts adjacent to inlets (A) and the recent beach nourishment project built to enhance breakwater performance at Holly Beach, Louisiana (B).

Coastal structures may be used to augment coastal restoration programs in some areas of the Louisiana coast in conjunction with, or in lieu of beach nourishment. Structures such as groin fields and segmented breakwaters can be used to slow littoral drift and reduce or eliminate erosion caused by increasing gradients of littoral drift. However, when the primary cause of shoreline retreat is overwash/breaching/barrier rollover (cross-shore processes) due to sea level rise and storms, such structures will be less effective and may not have significant, long-term, positive effects.

Several structural control measures have been proposed for the retreating Louisiana coast (e.g. Van Beek and Meyer-Arendt 1982; LDNR 1993, T. Baker and Smith 1997). Van Beek and Meyer-Arendt (1982) noted the unsuccessful performances of two riprap dikes and breakwaters on East Timbalier Island. These projects did not include beach nourishment, and the islands continued to migrate after the structures were installed. The structures were eventually abandoned offshore.

Picciola and Associates (2000) constructed a rubblemound along 6,300 feet (1920 m) of exposed shoreline to provide protective armoring for the restored island. However, these structures have not provided significant protection to the island, as demonstrated by recent monitoring data (e.g. Penland et al. 2003).

Groin fields and segmented breakwaters can seem to have positive effects when placed in limited numbers on an open coast because differential end effects are large compared to the small area to be protected. Positive results within a small segmented breakwater field cannot, however, be extrapolated to large segments of the shoreline with a similar degree of success. When five experimental breakwaters were built near Holly Beach in the mid 1980s, the positive results were dramatic, and a large shoreline salient built up in the breakwaters' lee. But in 1990 when 85 segmented breakwaters were built in the same area, only the two ends of the system (about 10 breakwaters) accreted sand. The beach behind the remaining 75 breakwaters continued to erode (CPE 2000). Development of a sediment budget for the area demonstrated that the breakwaters had indeed slowed total littoral drift and erosion rates by reducing wave energy uniformly throughout the protected area. But because the breakwaters depressed but did not eliminate the littoral drift gradient, erosion continued. At the ends of the breakwater system, the reduction in littoral drift when compared with the non-protected area was large enough to reverse the erosional trend.

At Raccoon Island, five breakwaters built in 1997 showed immediate results (Figure D.8-8), with sand build-up around and behind the structures. Recent monitoring data have shown that the beach retreat west of the breakwaters continues and may have been accelerated by the negative downdrift effects of these structures. Based on experiences with other areas (e.g. Holly Beach), it can be anticipated that the installation of additional breakwaters around the island may not provide the level of protection and accretion experienced by the first five experimental structures. Penland et al. (2003) demonstrated that the breakwater at Raccoon Island was significantly less cost-effective (dollars per acre of island created) than beach fills constructed on neighboring islands (e.g. Whiskey Island).

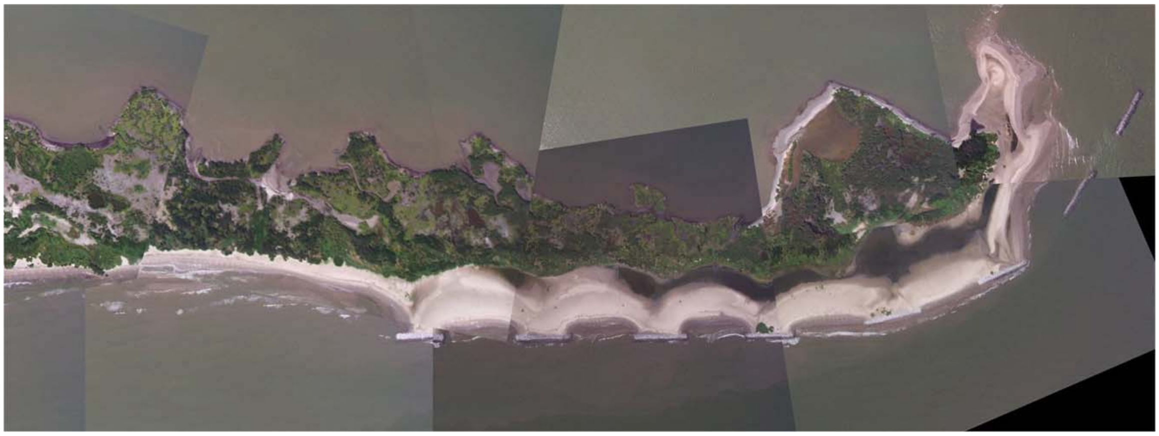


Figure D.8-8. Raccoon Island detached breakwaters, picture taken in September 2001.

According to Campbell and Jenkins (2001), to avoid downdrift impacts from the introduction of coastal structures, the littoral drift amount entering the protected area must equal the amount leaving the area. For this to be achieved, the groin field or segmented breakwaters must extend beyond erosion areas into downdrift accretional areas to the point where the littoral drift amounts are equal to rates entering the protected area (see Figure D.8-9). This concept would suggest that groin field and segmented breakwater installation be targeted to areas where the downdrift segment is accretional, or to areas on the end of littoral systems. Structural stabilization could also be considered in limited applications to protect infrastructure on retreating islands. This would enable the island to change shape, forming a bulge or an artificial headland around the protected feature. The new configuration could achieve littoral drift equilibrium with adjacent areas as the deceleration effects of the structural system were balanced by the acceleration effects of the changing shore orientation at the ends of the protected area (similar to a headland bay beach).

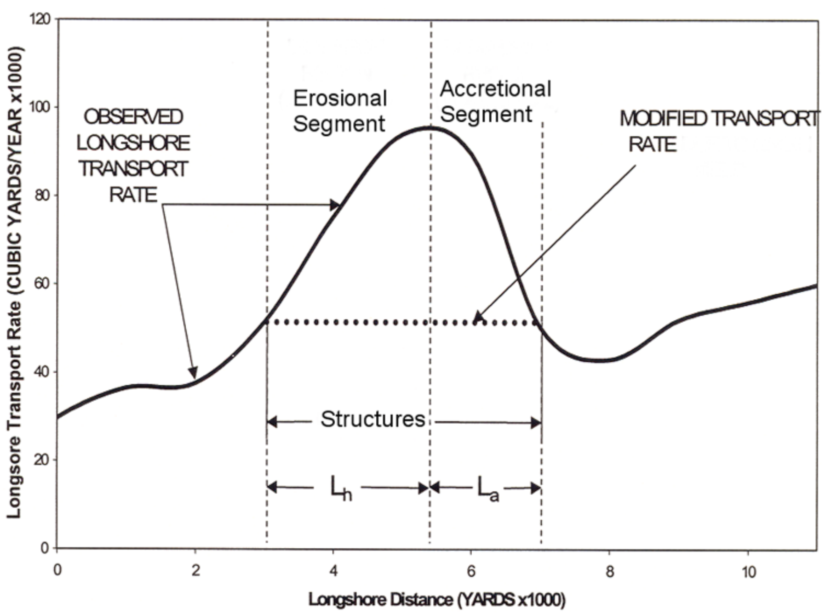


Figure D.8-9. Schematic diagram illustrating the strategy proposed by Campbell and Jenkins (2001) to stabilize an erosional area and minimize downdrift erosion.

In addition to traditional coastal structures, containment dikes (composed of rock or sand) may be needed to facilitate construction/closure of breaches or inlets. An overwash area east of Isles Dernieres was restored using fine grained (0.12 to 0.06 mm) dredge spoil from Cat Island Pass that was contained with 8 foot (2.5 m) high temporary retention dikes (Jones 1985). The project was successfully constructed to an average 7 foot (2.1 m) elevation that withstood hurricane activity in 1985.

Sand fencing enhances dune building process and should be incorporated into designs for the restoration of dune systems. Several fence shapes and configurations have been deployed (see Figure D.8-10). Because low dune areas are subject to breaching, dune fences should be placed parallel to the shore to promote uniform dune heights along the island. If fences are placed perpendicular or oblique to the shore, the total volume of dune building can be increased in some sections but will be diminished in downwind sections. This configuration produces low weak spots that are susceptible to dune breaching during storms. Breaching induced by oblique sand fences was observed on East Island by LDNR field personnel (Lee and Thibodeaux 2003, personal communication).

The selection of fill types, structures, or a combination of both, ultimately depends on the presence or absence of infrastructure to be protected, local coastal processes, and a cost/benefit analysis between structures versus nourishment strategies.

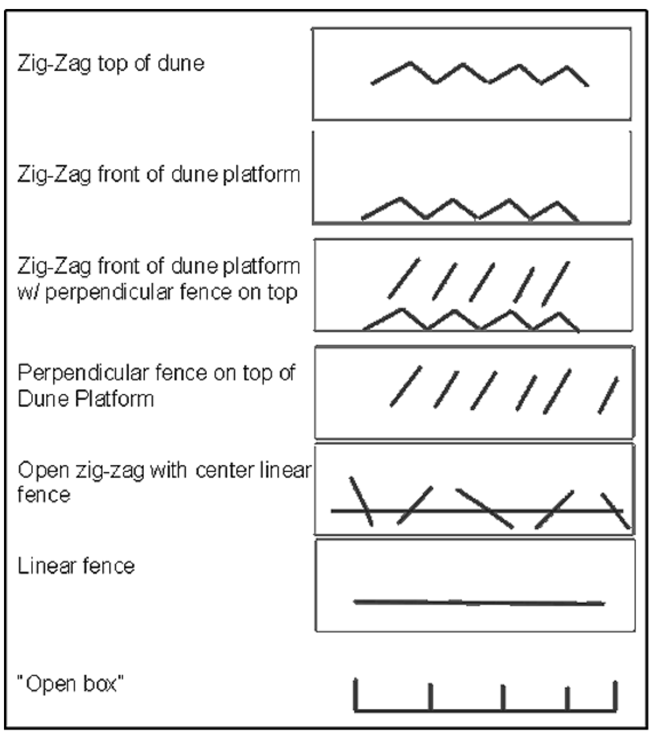


Figure D.8-10. Dune fencing designs that have been used along the various U.S. coasts.